

representation of quality-related information, we plan to use QAPM enhancing the approach from [11], which suggests using original KCPM for this purpose.

**5. Conclusions and Future Work.** In this paper, we outlined the basic concepts of a quality-aware intermediate model allowing capturing quality requirements semantics into glossary entries that can be verified by the end users. This model can serve as a source for information necessary on other stages of the quality-driven software process. In fact, we plan to use this model as core “scratch pad” of the problem domain for this process. In future, we plan to implement a software tool supporting this model, as well as perform all the described actions necessary to integrate QAPM into the software process.

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## GRAPHICS TECHNOLOGY TO MODEL THE PROBLEMS OF CALCULUS USING ANALYTICAL GEOMETRY

Ця стаття містить опис деяких методів візуалізації, що дають можливість використовувати технології комп'ютерної графіки для моделювання задач математичного аналізу та аналітичної геометрії. Детально розглядаються питання використання комп'ютерних зображень та робиться огляд використання комп'ютерної анімації для цієї візуалізації.

The paper contains some general background and some of the visualization methods that have been used to bring computer graphics technology to model mathematical problems of Calculus with Analytical Geometry. Computer-generated images have been length and breath of the paper as a source of additional background information on visual mathematics and an overview of selected animations concerned with mathematical visualization.

**1. Introduction.** The intention of this paper is to show the natural interrelationship between calculus mathematics and computer graphics. This article will concentrate for the most part in IT perspective on the progress, techniques, and prospects of mathematical visualization, emphasizing those areas of 2D and 3D geometry where interactive paradigms are of growing importance. [1]

Due to substantial changes that technology has brought in the recent years, instruction in mathematics will have to catch up with the new circumstances or else become increasingly irrelevant. With added pressure from rapid development in Multimedia, it is even more demanding to train our students to think clearly, critically, constructively, and creatively about problems they might encounter in real world. It is our job to help students to gain the ability to use mathematical methods and tools whenever they seem appropriate and helpful. Computer oriented mathematics courses should focus more on cooperative learning, problem solving, and investigative learning as an important part of education.

**2. Computer Algebraic System.** In the mid-eighties the availability of CAS for personal computers attracted mathematics educators to the possibility of using them in the classroom. CAS technology with its powerful combination of numeric and symbolic computation, colorful 2D & 3D graphics as in figure 1 and

figure 2, and programming facilities is a natural and logical continuation of the scientific and graphical calculators.

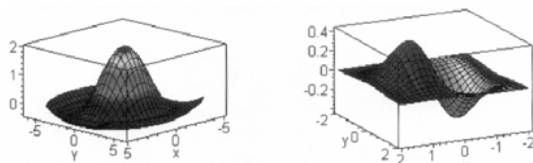


Fig.1 – Colourful 3D display of the functions

$$f(x, y) = 2 \frac{\sin(\sqrt{x^2 + y^2})}{\sqrt{x^2 + y^2}} \text{ and } g(x, y) = xe^{-(x^2 + y^2)}$$

The fresh approach of CAS has inspired many lecturers of calculus all over the world. It has, however, as any new system does, brought complications of its own. It requires more reading and more insight from the student than traditional calculus. This is exactly why the average student experiences difficulties with the new approach. More guidance should be given to assist the student in improving his reading skills in mathematics and to cultivate the required insight.

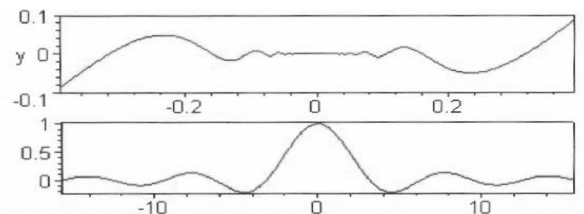


Fig.2 – Introducing important functions for future use

$$f(x) = x^2 \sin\left(\frac{1}{x}\right) \text{ and } g(x) = \frac{\sin(x)}{x}$$

**3. Students.** In the last few years, local universities start offering 4-year degree courses. Everyday student goes home after a tough day and plunges into time management crisis. In the unlikely event of having time to spare he might decide to pick up his Math text book. He finds the reading so much in a short period of time, mostly because he has not been trained to read mathematics and therefore does not do it in a proper directed way. Worse still, for the majority of students, it is written in their second language.

Come the following week, Mathematics becomes a priority on the evening before the tutorial session when the possibility of getting into trouble the following day becomes real. He does not quite remember the study material of the previous week but now he has to solve several problems. He reads through a problem and scans through the text book desperately trying to find something, a formula or an example, that will help him solve the problem. There definitely is no time to study the whole topic now. He is expected to apply concepts, but has never really studied the concepts themselves. However, the graphical representation as given in figure 3 will be enough to recall the whole thing.

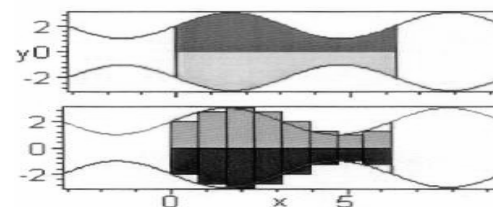


Fig.3. Students can easily skip the concept of finding the area between 2 functions

$$\text{and just use the formula instead } \text{Area} = \int_0^{2\pi} [f(x) - g(x)] dx$$

**4. Algebraic Functions.** Function is rapidly becoming one of the organizing concepts within mathematics education. The day is long past when mere mathematical computation is adequate. Students should not only apply and use a particular function but they are also required to create new functions which adequately represent the mathematical situation of hand. In addition to its mathematical power, the notion of function is uniquely suited for teaching and learning with technology.

The various types of functions may be studied through the analysis of the meaning for various rates of change, zeroes, maximum and minimum values within contextual settings. With an understanding of the various families of function, coupled with real world phenomena, connections are established, and students begin to see mathematical models as pictorial representations that have meaning.

Basic algebraic operations employ two powerful representations of functions, symbolic and graphical. The use of graphing technology provides both symbolic and graphical representations of functions. The use of graphing technology enhances students' understanding of the function concept. The combination of mathematical modeling and graphing technology offers an outstanding

opportunity for teachers to present the function concept in a meaningful manner.

Given two functions  $f$  and  $g$ , here are 5 basic algebraic operations on functions. Let's take for instance,  $f(x) = \sin(x)$  and  $g(x) = \sqrt{x}$ , then there will be,

$$(f + g)(x) = f(x) + g(x) = \sqrt{x} + \sin(x)$$

$$(f - g)(x) = f(x) - g(x) = \sin(x) - \sqrt{x}$$

$$(f * g)(x) = f(x)g(x) = \sqrt{x} \sin(x)$$

$$\left(\frac{f}{g}\right)(x) = \frac{f(x)}{g(x)} = \frac{\sin(x)}{\sqrt{x}}$$

$$(f \circ g)(x) = f(g(x)) = \sin(\sqrt{x})$$

as sketched in Fig.4a.

These are just few examples of how to enhance students understanding of concepts by giving them visual representation to accompany the verbal presentation and to discover properties of algebraic operations on their own. In this way, the students may achieve deeper understanding and longer retention of ideas.

**5. Pictures and Mathematics.** Calculus textbook has a long tradition of interest in visualization methods. The explosive development of mathematical software such as Matlab, Maple V, Mathematica, MathCAD, Mathview and so on was accompanied by intense activity in pedagogical illustration. The reader need only consult any such current text called Calculus to see the influence of this visual approach to mathematics. [1]

Using one of these computer algebra programs, we can get the answers to most of the questions on a traditional freshman math exam. These programs can differentiate, integrate, solve systems of equations and find various approximations. They produce quite nice 2D and 3D graphics, while they spare us the tedium of algebraic manipulation, and let us focus on the real issues rather than on the arithmetic [4].

Most of the well suited pictures figures and graphs in traditional textbook were drawn by graphic artists. Only some recent text that incorporates CAS starts to include computer generated images which have poor presentation standard. However, it is getting better as in Fig.4b.

The use of technology in mathematics teaching is not for the purpose of teaching about technology, but for the purpose of enhancing mathematics teach-

ing and learning with technology. The focus should be on learning with technology instead of mechanical procedure of integration and differentiation.

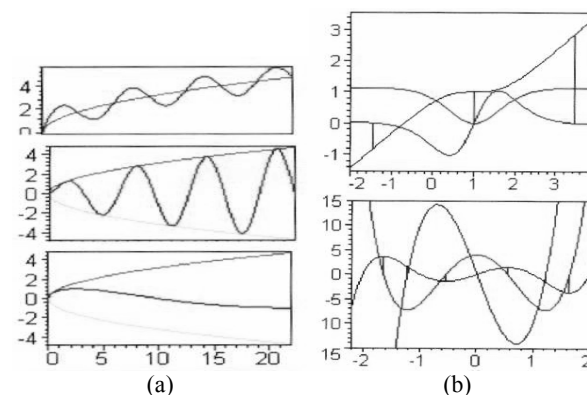


Fig.4. (a) Algebraic functions  $(f + g)(x)$ ,  $(f * g)(x)$ , and  $(f \circ g)(x)$

(b) The function, the first and second derivatives are drawn altogether to locate critical, extremum, and inflection points; the decision above

$$\text{is } f(x) = \frac{x^3 - 2x^2 + x + 2}{x^2 - 2x + 3}, \text{ and below is } g(x) = x^5 - 5x^3 + 4x$$

**6. Pedagogy.** CAS should be used to address worthwhile mathematics and support appropriate pedagogy. Content-based activities using technology should address worthwhile mathematics concepts, procedures and strategies, and should reflect the nature and spirit of mathematics. Activities should support sound mathematical curricular goals and facilitate conceptual development, exploration, reasoning and problem solving that will engage students in technology-augmented mathematical thinking as illustrated in Fig. 5a [5].

Pedagogic perspectives must be infused with an operational philosophy for implementing CAS. Simplicity must be the strategy. If CAS is a tool to be experienced in a lab setting, then precise and well crafted exercises and projects are essential. Students who have unpleasant experiences with CAS are not likely to enjoy the extra effort it takes to master CAS and still master the pencil and paper skills of the traditional class. Adequate help in lab setting is a necessity, and seeing CAS used to solve problems in the lecture is a prerequisite. Students need to see how CAS can be used to explore mathematics and to solve problems [6].

Technology-enhanced activities should involve students in higher-order mathematical thinking and should not engage students in carrying out proce-

dures and finding answers without appropriate mathematical and technological understanding. Future educator should emphasize on content development and pedagogy, and not just learning how to use the software [5].

**7. Take advantage of technology to enhance teaching.** Activities should take advantage of the capabilities of technology, and hence should extend beyond or significantly enhance or facilitate what could be done without technology. Using technology to teach the same mathematical topics, fundamentally the same ways, that could be taught without technology does not enhance students' learning of mathematics and rely on the usefulness of technology. Furthermore, using technology to perform tasks that are just as easily or even better carried-out without technology may actually be a hindrance to learning.

Learning activities should incorporate multiple representations of mathematical topics and/or multiple approaches to representing and solving mathematics problems. Furthermore, use of technology allows students to set up and solve problems in diverse ways, involving different mathematical concepts, by removing both computational and time constraints [5].

It is even possible now to show interesting new broader view (from the student's point of view), thereby extending the teaching of mathematics such as a combination of several topics and Calculus as given in Fig.5b and Fig.6.

**8. The Appeal of Interactivity.** Application in multimedia will not be complete if not for the addition of one more element, that is, interactivity. Interactivity becomes a natural element of application created on PC with the help of CAS software. Interactivity is attractive in the world of digital multimedia application because it allows the user to become part of the whole experience. To be able to interact with the CAS and produce result base on this interaction is a very seductive characteristics of modern day mathematics [4].

Interactive computer graphics methods provide new insights into the world of pure geometry. This paper describes some recent attempts to use computer graphics to understand deep problems in modern Calculus. Typical geometric problems of interest to mathematical visualization applications involve both static structures, such as complex numbers, and changing structures requiring animation. In practice, it is quite challenging to construct intuitively useful images. Nevertheless, despite the apparent limitations of visual representations, their utility is far from being completely exploited [1].

Interactivity and navigation are at the heart of multimedia. Navigation controls can be developed to have certain capabilities in a multimedia application. They can be used to:

- Control the pace of the content;

- Provide a history of links;
- Provide feed back to the user's interaction; and
- Provide cross-referencing to related information.

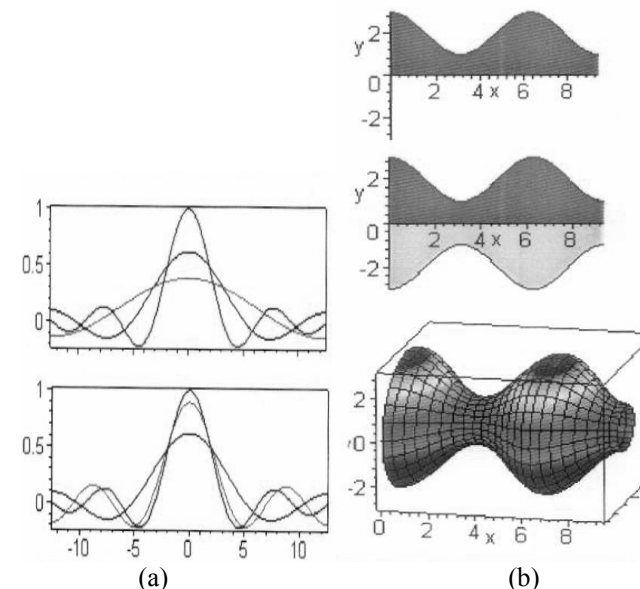


Fig.5. (a) Function  $\frac{\sin(x)}{x}$  is being approximated by the Fourier series.

The convergence of Fourier series is graphically explored here

(b) Evolving  $\Omega$  (area under the graph of  $f(x) = 2 + \cos(x)$  on  $[0, 3\pi]$ )

about x-axis. Volume is  $\int_0^{3\pi} \pi [2 + \cos(x)]^2 dx$

Navigation controls include hypertext which is a navigation tool that links words and/or pictures to navigate through textual information. Complex world of animations have captured the hearts of the educators all over the world and paved the way for animation technology to take off. Now-a-days mathematical software developers are also incorporating animations to provide some jazz and oomph to create dazzling results to an otherwise static presentation [2].

**9. Animated Images.** Animation is the result of a creative process to substitute the real thing for computer-generated images sequences together to give motion

as drawn in figure 7a. The use of animations in mathematics is both refreshing as it is complex. It provides a light-hearted relief in a serious and static presentation. It can easily enhance the message of the presentation with a realistic image. It has been used to demonstrate crucial concepts that can not be otherwise explained by text or graphics. Animations fall into two categories: 2D and 3D animations. 2D animations are the more as they are easier to create and cover a wider variety of motions. 2D animation consists of individual image sequenced together to display motion. Motions are simple to create but give the audience a dynamic experience to the presentation [2].

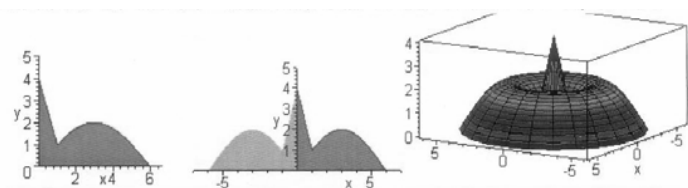


Fig.6. Evolving  $\Omega$  (area under the graph of piecewise function  $f$ )

$$\text{about y-axis } f(x) = 2 + \cos(x) \begin{cases} 4 - 3x, & 0 \leq x \leq 1 \\ 2 \sin\left(\frac{\pi}{6}x\right), & 1 < x \leq 6 \end{cases}$$

and  $\int_0^1 2\pi x f(x) dx + \int_1^6 2\pi x f(x) dx$  requires an integration by part

Animated images are drawn separately with each image depicting a specific incremental movement. Then all the images are combined together and sequenced to display rapid movement. Nowadays, the computers have so much power that animated images can be ported over to the computers and created on the desktop. Maple V release 5 has graphics tools that allow us to create each image and import into an animation package to be sequenced and exported out as appropriate file such as GIF format to be animated in an animation package. Graphics Interchange Format (GIF) is made up of multiple GIF images sequenced together in one file to give motion. Animated GIFs are used in many websites to animate titles and headers and read by popular Web browsers.

It is much more realistic to make use of 3D animated images to tell theoretical concept. 3D animations make images look more realistic. Once the object is modeled, textures and colors can be applied to it. Lights and cameras can also be placed to give the 3D object some shadow and shading [2].

The real power of computer graphics lies in its ability to accurately/approximately represent objects of interest within its limited resources

combined with its ability to allow the user to interact with simulated worlds. To understand how significant these features are, consider this: our entire common-sense knowledge of the physical world exists only in our mental models and has developed, through interaction, a mental picture that enables us to predict with some accuracy what is physically reasonable [1].

However, significant change in teaching style and learning process can be made in showing/displaying derivatives, integrals, approximation techniques such as Newton Method (Fig.7b), orthogonal polynomial, Taylor's series, Fourier series besides estimation of derivatives from numerical data, numerical methods of integration.

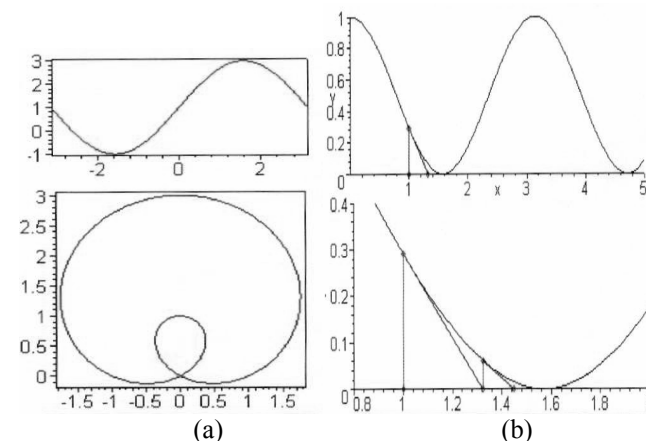


Fig.7. (a) An effective display of function on polar coordinate system should use an animation of 2 graphs simultaneously  $f(x) = 1 + 2 \sin(x)$  as above.

(b) Visual display of the conceptual movement of Newton's Method as it gets closer to the root. The sample function in this instance is  $f(x) = \cos^2 x$

**10. Electronic Classroom.** The immediate trend is to create online "interactive books" which incorporate interactive graphics demonstrations into a hypertext system for teaching calculus. Besides reading text, the student can click on words to get definition, follow links to related subjects, and interact with a multitude of 3D visualizations whose parameters can be manipulated to help understand a wide array of concepts. A typical example permits the user to "fly" on a curve in 3-D space. The "interactive book" approach of situating interactive graphics within a written context is an appealing educational paradigm [1].

Education is not only about the transfer and absorption of information but it also involves the active interaction among students and between student and teacher. There are many situations when it will be effective and efficient to use electronic tools to support and deliver education. In these circumstances it will be vital that the full education experience is delivered, including the opportunity to interact and collaborate.

**11. Prospects for the Future.** Mathematical visualization, like other areas in the rapidly developing field of visualization since, is still defining itself. Many of these techniques can be adapted to the emerging virtual reality medium as interactive performance continues to improve. There are clearly many areas of development that are appropriate for the participation of computer scientists with skills in interactive interface design, computer graphics, efficient algorithms, and perhaps data management. One can also conclude from looking at the images, graphic arts and design skills also have a unique role to play in improving the quality of graphical communication.[1]

**12. Conclusion.** Today, there is a live activity in the area of producing mathematically oriented computer graphics animations that are shown at computer graphics conferences and mathematics seminars. It is time to consider teaching a modern, reform calculus course that is a lean and lively group of topics from a dynamical systems perspective and uses technology to treat most topics graphically, numerically, and analytically.

Using animations add dimensions of motion and mobility to images in a presentation. Dynamic visual imagery greatly enhances a presentation's value and, as with the case of 3D animations, provides a simulation without sacrificing the speed of the presentation or disk space. Current state of bandwidth still limits the use of 3D animation in teaching mathematics to its fullest potential.[2]

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## AN ARCHITECTURE FOR OLAP-BASED ENTERPRISE-LEVEL DECISION SUPPORT SYSTEMS

У статті пропонується розробляти стратегії розвитку підприємства на підставі поліпшення ринкової позиції підприємства та фінансового положення. Для розробки стратегії розвитку використовується система підтримки прийняття рішень. Пропонується використовувати OLAP- технології для інформаційної підтримки алгоритмічних модулів.

In this work it is considered that the strategic development of an enterprise is aimed at the improvement of the market position and financial status. Decision Support System for elaboration of development strategy of an enterprise is used. Suggested information support for algorithmic modules realization is based on OLAP technology.

**1. Introduction.** At present the strategic management of an enterprise becomes more and more topical. Market competition increases, the companies implement new innovation decision to expand their influence on the market of goods or services. This is leading to necessity of quick and due-time reaction to action of the competitor, as well as to necessary analysis of development strategy and its possible change. Experience shows that in modern environment it is impossible even to survive without reorganization of the management system of an enterprise on the principle strategic planning, not mentioning a successful operation. Including every component of the social reproduction system - production, distribution, exchange and consumption - the strategic planning turned out into the main moving force of a social reproduction. The monitoring system is widely used as well as the analysis of external and internal environmental factors; found as a result of analysis of possible threads to an enterprise, also its strong and weak sides serve as the information basis for setting and correction of strategic aims and ways to achieve them [1].

**2. Strategic management of an enterprise.** Strategic management is considered to be the dynamic aggregate of interdependent management processes (fig.1). There is a stable feedback. This is the main peculiarity of the strategic management structure.

In this work it is considered that that the strategic development of an enterprise is aimed at the improvement of the market position and financial status.